Registration as Research Student for Doctoral Degree

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Synopsis for Registration as Research Scholar

for

Doctoral Degree

On

Efficient Framework Development for Enhancing the Performance of Li-Fi Based Network

By

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Abstract:

Wireless data communication has become an essential utility in our private and business lives. There are more than seven billion smartphones primarily used for personal communication. There is a sharp increase in the number of wearable; there will also be hundred billion internet-of-things (IoT) devices that will underpin our smart homes and smart cities in near future [1]. Currently, all these digital wireless services use radio frequencies which are part of the wider electromagnetic spectrum. However, the lower frequency bands those are easy to use and have desirable propagation properties already had multiple uses. Consequently, there is very little spare resource to support the exponential growth in demand. To get better bandwidth, efficiency and speed, a new technology Li-Fi (Free Space Optics) has evolved. It uses the unused visible spectrum and reduces the load on radio spectrum. Data transmission in Li-Fi is about 100 times faster than Wi-Fi. License free bands, robustness, high data rate transmissions, and negligible signals interference appear promising for high speed wireless communication through Li-Fi [1].

The factors which have an influence on performance of Li-Fi based networks are flickering of LEDs [1], data security [2][3], data loss [4], interference with external light sources like sun [5], normal bulbs, etc. These issues can be addressed with various advanced techniques like soft computing methods, which will improve the network performance leading to achieve secure, fast and lossless data communication.

1. Introduction

The word Li-Fi was first coined by Prof. Harald Haas at the University of Edinburgh in 2011. Li-Fi stands for Light Fidelity. This technology has vast applications and has fascinated the attention of large numbers of users as it has proved to be better alternative to Radio Frequency (RF) technology for reliable and feasible deployment of communication networks [1]. It is a bidirectional and wireless mode of communication using light. Li-Fi can be simply put to be Wi-Fi but instead of radio waves, light is used as a medium. Here, data is transmitted using light whose intensity varies faster than human eye to capture. Instead of using modems, Li-Fi uses LED bulbs with transceiver. Based on this variation, communication occurs digitally and in terms of Gigabytes per second.

Some issues like data security, data losses due to opaque objects, noise due to external light sources, flickering of LEDs, adverse weather conditions [6] may affect the performance and to eliminate them some modification can be proposed.

2. Review of Literature and Development in the subject (Previous work done in the relevant area):

Literature survey briefs about the previous efforts and utilization of algorithms for improving the performance of space optical communication. The most recent and key references are summarized below:

The author in [1] explained open research issues like Flickering, requirement of different levels of illuminance, performance of the different channel coding schemes, noise, etc. Flickering is the fluctuations noticed by humans in the brightness of a light. Flickering is either inter-frame flicker or intra-frame flicker depending on the nature of the brightness of the variations. The intra-frame flickering is because of the brightness difference between bits in a frame while the inter-frame flickering is due to the brightness difference between the idle period and packet frame transmission period.

In [2] the authors had proposed and demonstrated a secure VLC system using data superposition of different LEDs. Hence, a secure VLC zone can be created, and this can protect the information from being detected by adjacent users (or eavesdroppers) with similar light illumination.

In [3] the author analyzed the risks of signal jamming, data snooping and modification in VLC infrastructure and concluded that it is particularly prone to data-security risks. The current IEEE standard 802.15.7 does not provide adequate MAC-level protection against physical level risks

In [4] the authors demonstrated that Li-Fi may not provide a uniform coverage in terms of data rate performance mainly due to inter-cell interference (ICI) and blockages. Therefore, a hybrid Li-Fi/RF network is proposed to mitigate the spatial fluctuation of data rate offering a system throughput greater than that of stand-alone Li-Fi or RF networks. Here three factors are taken into account: blockages, Li-Fi ROA and user data rate requirement. An EGT based load balancing algorithm is proposed to improve the user QoS.

In [5] the author proposed new mixed integer linear programming (MILP) models in order to maximize the total capacity of a wireless visible light communication (VLC) network subject to power and ring (or tree) topology constraints. Further he proposed a new relaxed version of the algorithm to compute optimal solutions for all the exponential models with up to 500 nodes. Further he suggested main drawback of VLC that it does not work efficiently under sunlight places.

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In [6] authors evaluated the effects of bad weather conditions on FSO link having range 500 meters up to attenuation of 70 dB/km. The suitability of three optical transmission windows, with the FSO link is analyzed and compared. Simulation parameters such as Quality factor, minimum BER and Eye diagram are taken into consideration. The results of analyzer for various transmission windows are compared to find out the most suitable wavelength of transmitter under adverse weather conditions for reliable communication.

In [7] the authors proposed a light encryption scheme. The original visible light signal sending from the lamp can be first received by proposed light encrypter; then, the information can be encrypted, which can then be emitted as visible light by this light encrypter.

The authors explained in [8] the ways of implementation for WDM technology that is specific for high capacity fiber optic systems, using FSO terrestrial links. It has calculated the BER value for each CWDM/DWDM channel, idealized and real conditions (with attenuation). The simulations are made under Optiwave environment for a system with 8 CWDM/DWDM channels, performance evaluation is made using the eye diagram, WDM and optical spectrum analyzers.

The authors in [9] have analyzed the transmission performance of WDM-FSO system under the influence of atmospheric and optical nonlinearity. The analysis shows that FSO-WDM shows greater degradation due to interaction between optical and atmospheric turbulence. The optimization of OMI is also essential to avoid clipping induced distortion. The study could be extended for M-PSK and OFDM, to investigate the robustness of various modulation formats.

The authors in [10] presented a comprehensive survey of FSO communications and networks, ranging from home, to terrestrial, and to satellite optical wireless networks, to provide the architecture, big picture, and state-of-the-art of this important wireless technology. They provided detailed discussions of research challenges like atmospheric turbulence, which makes link quality unreliable and PAT. Atmospheric turbulence affects the propagation of optical signals, leading to degraded performance directly under various forms such as SNR (Signal-to-Noise Ratio), BER (Bit per Error Rate), and outage frequency. PAT (Pointing, Acquisition, and Tracking) technique, which is extremely important in FSO systems because of its unguided narrow beam propagation through free space.

3. Objectives of Research:

Following are the objectives of research:

1. To develop framework for visible light communication (VLC)
2. To identify suitable algorithms for issues like data loss and data security
3. To demonstrate use of different methods to improve communication.

Brief Methodology followed to achieve above objectives is summarized below:

- The study of suitable tools like NS2, Netsim, MATLAB, OMNet++, etc. to design model for VLC. Its performance validation and basic checks will be performed.
- Network performance improvement problems are usually solved with different constraints like cost, efficiency, throughput, data integrity, minimization of interference and fluctuations in input data etc. This can be achieved by proper selection of soft computing strategies.
- The cryptographic mechanism of the IEEE 802.15.7 standard is based on symmetric-key cryptography and uses keys that are provided by higher layer processes. To improve data security, various security algorithms are compared to propose suitable one.
- To study and demonstrate use of different methods for improved communication
- After performing preliminary trials of the soft computing algorithms for network improvement, these algorithms and methods will be demonstrated for detailed near real-life Li-Fi enabled network problems.

4. Importance of problem in Society application:

The VLC is emerging field in wireless technologies which will reduce the burden on Wi-Fi and Bluetooth and will provide fast, license free, electromagnetic interference free communication. It uses the unused visible spectrum and reduces the load on radio spectrum. This technology has vast applications where the use of Wi-Fi is limited or banned e.g. hospitals, petrol stations, power plants etc. It also takes out the adverse health effects of using electromagnetic waves. Unless light is seen, data can't be hacked and so data transmission is secure for indoor applications. These technologies are expected to provide a wide variety of real-time applications; hence, there is a vital need to provide quality-of-Service (QoS) support.

5. Proposed work Plan:

Year-wise Plan of work and targets to be achieved

Sr. No.	Year	Details of work carried out
1	2017-18	Literature Survey. Problem Formulation and Synopsis Write up. Course work completion
2	2018-19	To develop model for VLC(Objective-1), To carry out communication (Objective-2)
3	2019-20	To identify suitable algorithms for data related issues(Objective-3) To demonstrate use of different methods to improve communication (Objective-4) Summarization, comparative analysis and publications

6. References:

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